**Does Nutrition Have a Significant Effect on How Our Immune System Functions?**

# **A Research Project by Ashley Blake & Heath Cady**

Does nutrition effect how our immune system works? These are the questions we have tried to answer through a lot of research, as well as a survey about eating habits and immune system efficiency of Amador High School students. We started our topic, looking at nutrition in mice, and how it would affect them mentally and physically. Through conversations with Mr. Thiel and a lot of thought, we decided that it would probably be a bad idea to use mice as subjects. As we changed our topic by using humans as subjects, we began considering ways to incorporate nutrition into a study. Mr. Thiel suggested looking into its effects on the immune system. We decided that this would be a better and more realistic project to do. Since we were both interested in nutrition, probably because both of us are athletes, as well as Californians (who tend to be very health-conscious). I was very excited in the shift from mice to humans because I can benefit more from the information we collected through doing this research project. We decided the best way to find evidence supporting our hypothesis would be by creating a survey about the topics involved. Most of our research was focused on the immune system (what it is, how it works, components of it) and nutrition (vitamins and minerals that have a direct impact on how the immune system functions).

THE IMMUNE SYSTEM

What determines what makes us sick? The human body comes in contact with many foreign substances all the time. For example there are bacteria, fungi, viruses, and many other different chemicals. These factors often cause illness in the organism they infect, and sometimes even death. Yes we have drugs and medicines to fight off these invaders, but shouldn’t we have our own way off fighting off these diseases on our own? We do, and it lies in our *Immune System*.

The study of the Immune System is known as Immunology. (1) Anything that relates to fighting off disease in any part of the body all falls under Immunology. Say there is a white blood cell eating infectious bacteria, or a specific organ producing antibodies to kill foreign invasion, it’s all studied under immunology. It studies what the immune system is composed of and what their functions specifically are. Many different cells, organs, and chemicals produced by our bodies fully make up the immune system. (2) And their soul mission is to protect us from disease no matter what the cost is.

Since disease comes in many forms, the immune system has so many of its own ways of fighting them off. Viruses are often a huge problem to the immune system. We are exposed to viruses every day, which range from the common cold to HIV. Most of these diseases can be fought off by the production of antibodies. Antibodies are produced by what we call B-cells. The body contains millions upon millions of these B-cells, which make for many different types of antibodies. The B-cells will immediately detect a foreign invader. Once it does, it and many other cells will release antibodies that will easily lead to the destruction of that invader. This is also a good way of killing invading bacteria as well. But without T-cells, B-cells would often not function. T-cells are often called helper cells. T-cells detect foreign invasion to the body as well, but instead of making antibodies, they produce proteins. (3) These proteins send signals to the B-cells, telling them to make antibodies. Infections are also dealt with by means of T-cells, but these are called inflammatory T-cells. They only specialize in forms of infections and other forms of injury. The third, and last type of T-cells is Nonspecific Effector Cells. They are able to fight off invasion without help from other cells. Macrophages can move freely around the body to destroy invaders and neutrophils can eat infected cells. And another major helper T-cell in the body is the Natural Killer (NK) cell. These cells are also referred to as cytotoxic T-cells. (4) They are able to kill any harmful cells that have been infected by a virus or fast spreading cancerous cells without any outside assistance.

Most of these Helper T-cells play very important roles all throughout the body, but there are places where their attendance is severely mandatory. They are almost always located in regions of the body called the Reticuloendothelial System, also known as the RES. The RES consists of structures such as the liver, spleen, intestines, lymph nodes, bone marrow, and lungs. (5) The RES is considered to be the areas of the body that clean out harmful waste that could do horrendous damage. These areas are prone to have a high risk of cancer, because of rapidly dividing cells. Which is why the quantity of T-cells is so high in the RES, to prevent the possibility of cancer and disease.

There is also the Complement system. Complement can kill an invading bacteria or an infected cell on sight. It attaches itself to the surface of the target cell, allowing any certain macrophage or neutrophil to come destroy it. It can also literally poke holes in the cells membrane. This will cause the cell to flood and burst, which will destroy the cell immediately being a very effective way of fighting off disease.

One of the biggest problems for the immune system is cancer. Cancer comes in so many different forms and can infect some many different parts of the body. These abnormally shaped cells will divide very rapidly and literally take over the body’s normal cells. Leukemia is the most common form of cancer we know of today. It is a dramatic transformation within blood cells causing quite abnormal changes in bone marrow and lymphoid organ cells. (6) Yet they can also transform cells all throughout the RES region. There are about five different types of leukemia, and they all pretty much dominate over the immune systems helper T and B-cells. This makes cancer very hard to treat, but treatment for cancer has greatly improved with the last few decades making the performance of our immune system much more efficient.

There are many other hurdles that the immune system has to jump through. There is never a free ride anywhere. Viruses are one of our immune systems greatest of foes. They are not alive and are not active until they make contact with a host cell. Once they release their genetic information into the cell, the multiply and overpower the cell until it ruptures and releases more viruses throughout the body. Some very common viruses today are influenza and the common cold virus. Since we are pretty much exposed to viruses like this almost everyday, our bodies can easily identify them and destroy them before there is any real chance of infection. Yet often times, the body will come in contact with a virus that it has never seen before. The virus easily tricks it because it is doing what it normally does, infecting cells and multiplying. But the cells that these viruses go after are specifically the T and B-cells. Because of the lack of these cells, there are no antibodies produced to destroy these foreign invaders. This will often lead to severe illness and in most cases death to the host organism. Some examples of these viruses are HIV (AIDS) and Hepatitis (which specifically attacks the liver our main source of metabolism also called RES), which are often referred to as Sexually Transmitted Diseases or STDs. Cures are so difficult to find for these diseases because of their ways of attack upon our cells.

Naturally with disease comes science, and with science comes technology, and with technology comes cures for many of the diseases we know of today. We have cures for many bacterial and viral infections. Antibiotics are what we have to help the immune system kill off invading bacteria. And we truly have no man made cures for viruses, but we do have what is called a vaccine. Vaccines are meant to trick the immune system, but in a good way. Every virus has a defined protein shell or coat. A vaccine is a copy of a specific shell of a specific virus. It is injected into the body and immediately seen as a foreign invader. T and B-cells are frantically at work trying to destroy this potential threat. Once they have done their job, the immune system has a memory of this, and if the actual virus invades it, it will easily dispose of it. Therefore the host easily avoids infection. As for the viruses we have no cures for, it’s because they attack the very cells we have to fight off these viruses are they will lie in dormancy awaiting the body to go through an immediate stage of excitement or stress which will trigger them to be active once again.

*“ Let food be thy medicine and thy medicine be thy food”* ~Chinese Proverb (7)

NUTRITION

“Only recently have scientists begun to investigate and unravel the fascinating and complex workings of the immune system, including its dependence on diet. It is increasingly clear that you can manipulate your immunity by what you eat.” (8)There is a direct relationship between the kind of foods you eat and the strength of your immune system. There are vitamins and minerals that are essential for the immune system to be efficient. One food in particular has been repeatedly named as having an extremely advantageous effect on our immune system. This food is yogurt. Yogurt kills bacteria as well as boosting immune functions. It increases production of gamma interferon and antibodies, as well as increasing activity of NK cells. According to Food-Your Miracle Medicine, foods that stimulate immunity include yogurt, shiitake mushrooms, garlic, foods rich in beta-carotene and zinc, and a low fat, vegetarian diet. Certain foods affect how neutrophils and lymphocytes (white blood cells) perform against bacteria and infections. Since white blood cells are key players in the immune system’s efficiency, any negative effect on their performance could lead to disaster. “Nutrition is a potent tool in preventing many illnesses, in curing some, and in supporting conventional medical practices.” (9)Having a well-balanced diet (based on the food pyramid) can help protect you from many infections, especially bacterial and some viral. There are specific vitamins and minerals that extremely important in fighting off sickness.

## VITAMINS

**Vitamin A**: Also known as beta-carotene, one of the most important nutrients in strengthening our immune system. It keeps the mucous membranes in your mouth, respiratory passages, and urinary tract moist, therefore ensuring resistance to infection. Vegetables that are green and yellow, such as carrots, sweet potatoes, dark leafy greens, apricots, cantaloupe, and winter squash, are rich in beta-carotene. (10)

**Vitamin B**: There are many B vitamins. Some of the main ones are Thiamine, Riboflavin, Niacin, B6, B12, and Folic Acid. B6 vitamins are known as the building blocks of proteins. (11) B6 is found in banana, salmon, chicken, liver, and sunflower seeds. Riboflavin increases the production of red blood cells and lengthens their lives. It also helps red blood cells to maintain a high iron level. Riboflavin can be found in yeast, liver, wheat germ, eggs, milk, and green leafy vegetables. (12)

**Vitamin C**: “The speed with which the immune system can react to invading viruses, etc., is directly dependent upon the immediately available supply of vitamin C.” (13) Vitamin C protects cell membranes against thin walls, through which blood cells can move, which results in scurvy. Vitamin C contains interferon, which is the first attacker to the disease, even before the antibodies! Vitamin C-rich foods include kiwifruit, sweet peppers, broccoli, cauliflower, kale, lemons, strawberries, papaya, asparagus, spinach, cantaloupe, oranges, grapefruit, and tomatoes. (14) People who take Vitamin C do not tend to have as many, and as severe of colds.

**Vitamin E**: These vitamins repair free radicals’ damage. Free radicals are the products of splitting molecules of water, and cause blood cells to clump and infections can colonize. Vitamin E escorts the blood cells that are part of oxygen transport so they cannot destroy cells unnecessarily. “Vitamin E boosts the body’s cell-mediated immunity” which protects us from bacteria, viruses and cancer. (15) Vitamin E can be found in eggs, nuts, whole-grain products, and margarine. (16)

**Vitamin K**: This vitamin can be produced in the human intestines by bacteria. Vitamin K is essential because it causes blood to clot, so bleeding to death does not occur. However, only a small amount is needed for its function to be carried out. Vitamin K is also needed for maintaining healthy bones. Foods that contain significant amounts of Vitamin K include yogurt, liver, and dark leafy vegetables.

## MINERALS

**Zinc**: “Zinc deficiency rapidly diminishes anti-body-and-cell-mediated responses in both humans and animals.” (17) When there is a deficiency, large amounts of T and B cells are lost in bone marrow. Zinc is also involved in all new cell growth. They produce antibodies and T-cells. Zinc is one of the trace elements. Males, 11 years and older, should take 15 mg a day. Females, 11 years and older, should take 12 mg a day. Zinc is found in oysters, herring, clams, wheat germ, bran, oatmeal, liver, nuts, beef, lamb, peas, chicken, and carrots. (18)

**Selenium**: Although it is not clear why exactly Selenium is necessary for immune system efficiency, it is clear that it is. Some theories are that it helps protect prostacyclin, which in turn, promotes immune factors. It is also thought that it is a “shield for the body’s ‘warriors’ as they douse the invading organisms with lethal free radicals.” Selenium is found in Brazil nuts, soybeans, tuna, seafood, meat and whole-grains.(19)

**Calcium**: Calcium is very important in preventing cancer because it attaches to fats and carries them out in feces. Vitamin D is essential in increasing calcium absorption. Calcium is most abundantly found in cooked bones, yogurt, turnip greens, broccoli, milk, and other dairy products. (20) Tofu and dried beans are also a great source of calcium. (21)

**Iron**: It helps in the creation of new blood when blood is lost due to illness or injury. It also helps to increase immune response. Iron is a component of hemoglobin. (22) Iron is found in pork liver, cream of wheat, clams, beef, veal, chicken, fish, spinach, asparagus, prunes, raisins, and seaweed.

**Copper**: This mineral, along with zinc, fights free radicals, which cause abnormality in cell growth. Copper helps in producing antibodies that fight infection. It is an antioxidant in the blood stream. Copper is found in shellfish, liver, cherries, nuts, cocoa, and gelatin. (23)

Other foods should be taken with serious moderation. Although in modest intake, they can be beneficial, in substantial amounts, they can cause serious problems.

**Protein**: Proteins are essential to the immune system, but if taken in a very large amount, can cause cancer. Ten percent of the human diet should contain protein, and half of that should be in plant food. (24) According to Liebig’s Hypothesis, only protein and a few minerals are the sole principles of a nutritionally adequate diet. (25) However, more recent studies have shown that high protein diets may not be the best nutritiously. Vegetarians’ immune systems appear to be more efficient because vegetables are a greater portion of their diet. Vegetables contain large amounts of beta-carotene, which is essential for normal functioning of our body’s defense. A study at the German Cancer Research Center “found that vegetarians’ white blood cells were twice as deadly against tumor cells as those of carnivores.” (26)

Other foods that lower your immune system’s capabilities include high-fat diets including corn, safflower, and soybean oils. (27)

Some other factors that could have an impact on the immune system are exercise, amount of sleep per night, and stress levels. Exercise is an important factor that can be physically helpful as well as emotionally helpful. “Scientists have shown that ‘dis-eases’ of old age may be caused by ‘dis-use’ of the body.” Sleep also can be a cause of a weakened immune system. Without an average of 7-8 hours of sleep a night, your immune system can become more vulnerable to bacterial and viral infections. Stress, as well, can cause your body’s defenses to weaken through too much worry, tension, or depression. According to Healing Nutrients, the main causes of disease and death are as follows:

* Stress level & Attitude: 25%
* Nutrition related: 25%
* Pollution: 11%
* Poor hygiene & poor medical care: 10%
* Sedentary lifestyle: 10%
* Infectious diseases: 3%
* Genetics: 3%
* Accidents: 2%
* Others: 11%

Although all of these factors impact our immune system, we focused on nutrition. However, we asked questions pertaining to these factors to help in determining if there were other variables that had a stronger impact than nutrition. In a way, it was our way of having a control group (by trying to eliminate lurking variables).